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EFFECT OF WEED CONTROL TREATMENTS ON THE GROWTH, YIELD AND QUALITY OF THREE CULTIVARS OF MAIZE (*ZEA MAYS* L.)

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Abstract

A field experiment was carried out in the fields of Field Crops Department – College of Agriculture - University of Anbar (Abu Ghraib) during autumn and spring seasons of 2017 in order to know the effect of weed control treatments on the growth, yield, and its quality of three, maize cultivars. The experiment was conducted as split plot arrangement in R.C.B.D with three replications of each treatment. The study included four treatments: weeds treatment (W_1), Hand removal of weeds (W_0), spraying with required recommended concentration of herbicide Arrow 75% WDG At a rate of 60 g h^{-1} (C_1), and a half required recommended concentration of the same herbicide (C_2).These treatments occupied the main plots while the genotypes occupied the subplots (Baghdad 3 – V_1 , Fajer 1 – V_2 and Al-Maha – V_3). The results showed that there is a clear effects of different weed control treatments in most studied traits under the study. The treatment of full concentration of recommended herbicide achieved lowest mean of weed density at harvest 13.89 and 15.56 plant m^{-2} in comparison with the control (weeded treatment) which achieved highest mean of weed density 55.22 and 56.33 plant m^{-2} for both seasons respectively, therefore the full concentration recommended herbicide treatment achieved the best weed control at harvest, 74.85 and 72.37 % for both seasons respectively. This has led to reduction in weed dry matter and increase in inhibition in it and that has reflected positively in improvement of growth traits and yield and its components. As for genotypes, Fajer 1 genotype was superior in showing its ability in reduction of weed density and their dry matter and increase in control of accompanied weeds and increase in most growth traits and yield and its components in a best degree in comparison with other genotypes under study. Fajer 1 genotype was superior in achieving highest average of plant height 176.33 and 174.95 cm, leaf area 5084 and 4712 cm^2, Net assimilation rate 7.795 and 8.299 g m^{-2} leaf day^{-1}, number of grain in ear 404.90 and 528.8 grain ear^{-1}, weight of 500 grain 138.58and 147.75g in turn all has been reflected to total yield in this genotype that gave highest average of total yield 4.11 and 5.51 ton ha^{-1}. Fajr 1 was also superior in achieving highest average in oil percentage in grains which gave 4.86 and 5.49 %. This is an indicator that this genotype is a very good accompanied weed competitor in comparison with cultivar of Baghdad 3 that gave the lowest average of most of the studied traits. We can be concluded from this study that the treatment of hand removal of weeds and the treatment of spraying with a required recommended concentration of herbicide at the control of weed plants, where they predominated in most traits, thus reducing the competition of the weed and thus increasing growth and yield, Fajr 1 was superior to the rest of the varieties in most traits of growth and the components of the yield in both season, and this was reflected in the total grain yield. Due to the differences in the competitiveness of cultivar with the weeds, we recommend studying the alleleopathic effects of the cultivar with the presence of the specialized herbicide in order to reduce herbicide spraying rates.

Key words: Weed, Arrow 75% WDG, maize Cultivars, Herbicide, Weed dry matter

Introduction

Maize (*Zea mays* L.) is considered a grainy strategic crop that has a great importance in the world. It is one of the main nutrition resources for containing a considerable amount of starch 80%, oil 4% and protein 9%, in addition to high percentage of carbohydrates of about 70%.It also contains many mineral elements and vitamins (Laurie et al, 2004; Khalaf & Boutros, 2009). There are multiple uses for maize as food for humans and in concentrated feed production for poultry and livestock. Its leaves, stalks and leftovers are used in paper industry, as well as its usage in dyes production and as a biofuel to compensatethe traditional cars fuel, thus it's called the king of crops (Subramanian & Subbaraman, 2010).

Currently, the United States of America is the first in the production of maize followed by China and India. It is believed that the origin of this crop is the Central America and Mexico (FAO, 2016). Despite the importance of this crop, its production remained of a low rate in Iraq, where the cultivated area for year 2015 was about 8528 hectare, and produced 3420 ton h^{-1} (statistical handbook for crop data, 2016). Compared with the global production, the cultivated area in 2013 was more than 175 million hectares which produced 880 ton h^{-1} (Anonymous, 2013).

Due to the importance of this crop, its cultivation has faced several problems which limit its productivity, problems like environmental conditions as high temperatures, humidity, lighting, appropriate cultivation activities, how vital the seeds of the class are, the accuracy of seed bed, the availability of suitable

humidity and the cultivation depth. As thatpresence of weeds reduces the photosynthetic efficiency, dry matter production, and distribution to economical parts and there by reduces sink capacity of crop resulting in poor grain yield. The competition between weeds and maize for growth factors, water, light, space, and nutrients reducing the quantity and quality of maize yield (Chikoye *et al*., 2004), and weeds cause significant losses reach to 60 % (Abouziena *et al*., 2007) Despite the great development in the production of various cultivars of maize, whether it was entered or derived which is trait by high productivity and suitability for different Iraqi environmental conditions, the crop still suffers low productivity and quality when compared to other types of cereal crops. Thus, this research aims to study the competitive capability of the items that are involved in this study for growing weeds, and determine the best treatment to control weed that gives the highest production with best quality and determine the best cooperation between two study factors to achieve the highest production with best quality.

Material and Methods

A field experiment was carried out in the fields of Field Crops Department – College of Agriculture - University of Anbar ((Abu Ghraib) that located on 44°21 E Longitude and 33°31 N Latitude during the spring and autumn seasons in order to find out the effect of Weed control treatments on the growth, yield, and its quality of three cultivars of Maize. The experiment was applied in the order of split-plot design according to the random complete block design (R.C.B.D) with three replicates.The study included four treatments: weeded treatment (W_1), Handremovalofweeds (W_0), spraying with required recommended concentration of herbicide Arrow 75% WDG At a rate of 60 g h-1 (C_1), and a half required recommended concentration of the same herbicide (C_2)) and these treatments occupied the main plots while the genotypes occupied the subplots (Baghdad 3 – V1 , Fajer 1 – V2 and Al-Maha – V3).

The farm soil was prepared well by following recommended agricultural practices accordingly and then divided into experimental units (3 x 3 m^2), each experimental unit included 5 lines of 3 m length and the planting density was 0.75 x 0.25 m. One meter was left between the experimental units. The distance between the three blocks was 1.5 m, and between a main plot and another distance was also 1.5 m.

Random samples were taken from the soil at depths of 0-30 cm before planting, representing the cultivated area for to know the chemical and physical properties of the soil. A sample of the water (well water) was also taken to measure the salinity of the (table 2). The seeds of the maize were planted after the standardization irrigation for the spring season on 10\4\2017, while the autumn season was planted on 19\7\2017, where 2 – 3 seeds were placed in the hole at depth of 2 – 5 cm and covered with suitable soil (Herbek and Murdock, 2001; Sarkis, 2006).

After germination was complete, irrigation was carried out as needed.The thinning is made after the seedlings appear, after the first two leaves are complete to one plant in eachhole with a density of 53333 plant h^{-1}. The NPK (N 18% and P 18%) fertilizer was added to the soil at rate of 400 kg h^{-1}, Nitrogen fertilizer was added in the form of Urea (46% N), at rate of 300 kg h^{-1} as three parts, the first part was added at planting, the second part was added when the plant is 30 cm high and the last part was added at flowering stage (Jade and Sahuki, 2011).

Sesamia cretica L. was controlled by using 1 L h^{-1} of liquid Diazinon herbicide (60% effective substance) on two stages, the first was after 20 of germination and the second after 15 days of the first stage for both spring and autumn seasons. (Al-jubori & Anwar, 2009). The harvest process was carried out when the crop showed signs of maturity as yellow leaves and stems, hard and dry seeds and the appearance of the black stigma that indicates the complete filling of seedsand no more nutrition are transmitted to it and each cultivar of maize, the spring season harvest was carried out on 27\7\2017, while the autumn seasons was harvested on 18\11\2017.

Studied Traits

First: The Type of weeds, their numbers and the rate of inhibition:

1- Types of weeds and their density (plant per square meter)

   The types of weeds are mentioned in tables (3 and 4), their density was calculated using squares method after 30 – 60 days of cultivation and at harvesting for (1 m^2) area for each experimental unit (Al-Chalabi & Almajidi, (2003)).

2- Percentage of weed control (%)

   The total percentage of weed control (%) was calculated on three stages, the first after 30 days of cultivation, the second after 60 days of cultivation and the last one at harvest, the following equation was used in this stage:

$$\%\ \text{of weed control} = \frac{\text{no. of weeds in weedy treatment} - \text{no. of weeds in other treatments}}{\text{no. of weeds in weedy treatment}} * 100\%$$

3- $$\text{Inhibition Ration } (\%) = 100 - \frac{A}{B} \times 100$$

Where A is the dry weight of weeds in weed control treatments, and B is the dry weight of weeds in weedy treatments (Al-Chalabi, 2003)

Second: vegetative growth traits:

1- Plant height (cm): the plant height is measured starting from the base of plant at soil level to the base of flag leaf (the node below the male part).

2- Leaf area (cm^2): the leaf area was measured for the leaf under the ear leaf using the following equation:

Leaf area = the square of leaf length × Correction factor (0.75) (Elsahookie, 1985)

3- Net Assimilation Rate (NAR) gm cm^{-1} day^{-1}

A sample of five plants was taken from each experimental unit randomly for the following stages, the first is at the start of male flowering stage, the second is the growth and harvest stage, where the Net Assimilation Rate was calculated as follows:(Hunt, 1982)

$$NAR = \frac{W2 - W1}{T2 - T1} \times \frac{Ln\,LA2 - Ln\,LA1}{LA2 - LA1}$$

Where:

W1: the dry weight for the plant sample in the first period T1.

W2: the dry weight for the plant sample in the second period T2.

LA1: the leaf size for the plant sample in the first period T1.

LA2: the leaf size for the plant sample in the second period T2.

Third: Yield and its components:

1- The number of kernel in each ear (grain per ear^{-1})

The kernel in the main ear was calculated for five plants representing the experimental unit at harvest.

2- The average of (500) grain (gm):

500 grains were manually counted in a random manner from each sample taken of five plants harvested from each experimental and them weighted using a sensitive electrical scale with a humidity of (15.5 %) and according to the following equation:

$$500\,grains\,weight\,with\,(15.5\%)\,humidity = \frac{100 - the\,original\,humidity}{84} 0.5 \times 100$$

3- Total grain yield (ton h^{-1})

The total yield of grains was calculated through harvesting the plants on the three middle lines, and the crop of the five plants was added to the result from each experimental unit, their ears were crumbled then transformed due to the unit (ton h^{-1}).

Fourth: Quality traits:

1- Oil Percentage (%)

It was extracted according to AOAC (1980) using the Soxhlet device for oil extraction, where 2 gm of the sample were taken, placed in model position and the extraction was achieved using (Diethyl Ether) with 30º temperature for 10 hours to avoid the damage of oil by the high temperature. The oil is weighted after the extraction process and the percentage was calculated.

Table 1: The Chemical and physical properties of soil and irrigation water before agriculture for spring and autumn seasons year 2017.

characters		Values for two seasons		Unit
		Spring season	Autumn season	
pH	Soil	8.6	8.7	---
	Water	8.0	8.1	
Electrical Conductivity EC (1:1)	Soil	2.3	2.5	ds/m
	Water	4.13		
Organic matter	O.M	1.74	1.72	%
Available N	N	55.0	56.2	PPM
Available P	P	11.50	12.4	
Available K	K	282.0	280.3	
Soil separates	Sand	7.4	6.3	%
	Silt	39.2	38.5	%
	Clay	53.4	55.2	%
Texture		Silty clay	Silty clay	--

- Soil samples were analyzed in the laboratory of the Agricultural Research Department - Abu Ghraib

Table 2 : Types of weeds in the experiment site of the spring seasons year 2017.

N	English name	Scientific name	Family	Life cycle	Plant type
1	Lambs auartey	*Chenopodium album* L.	Chenopodiaceae	Annual plant	Broad leaf
2	Wild beet	*Beta vulgaris* L.	Chenopodiaceae	Annual plant	Broad leaf
3	Nut grass	*Cyperus rotaundus* L.	Cyperaceae	Perennial plant	Narrow leaf
4	Purslane	*Portulaca oleracea* L.	Portulaceae	Annual plant	Broad leaf
5	Johnson grass	*Sorghum halepense* L.	Poaceae	Perennial plant	Narrow leaf
6	Rough pigeed	*Amaranthus retroflexus* L.	Amaranthaceae	Annual plant	Broad leaf
7	Field bind weed	*Convolvulus arvensis* L.	Convolvulaceae	Annual plant	Broad leaf
8	Purple Panic Grass	*Echinochlora colonum* L.	Poaceae	Annual plant	Narrow leaf

Table 3 : Types of weeds in the experiment site of the autumn seasons year 2017.

N.	English name	Scientific name	Family	Life cycle	Plant type
1	Johnson grass	*Sorghum halepense* L.	Poaceae	Perennial plant	Narrow leaf
2	Dwarf mallow	*Malva parviflora* L.	Malvaceae	Annual plant	Broad leaf
3	Nut grass	*Cyperus rotaundus* L.	Cyperaceae	Perennial plant	Narrow leaf
4	Priekly alhagi	*Alhagi maurorum medic* L.	Papilionaceae	Perennial plant	Broad leaf
5	Wild beet	*Beta vulgaris* L.	Chenopodiaceae	Annual plant	Broad leaf
6	Field bind weed	*Convolvulus arvensis* L.	Convolvulaceae	Annual plant	Broad leaf
7	Cogon grass	*Imperata cylindrica* L.	Poaceae	Perennial plant	Narrow leaf

Results and Discussion

The effect of different treatments on weeds density at harvest

The results of Table (4) showed that there are significant differences in weed control treatments, in terms of the numeral density of the weed plants. The weedy treatment gave the highest average of weed plants density reached 55.22 and 56.33 plant m^{-2} for both seasons respectively, while the treatment with herbicide with the recommended concentration gave smaller average for the trait that was 13.89 and 15.56 plant m^{-2} for both seasons respectively. This is due to the performance of Arrow herbicide affected the biological process of the weed plants, which led to killing weeds and reducing their density. This result Al-chalabi and Al-jubori (2012), Al-Khazali (2016) and Al-Hiti, who assured that using herbicide on weeds leads to reducing their numeral density.

As for the effect of the cultivars on this trait, the results indicated that they had an intangible effect, Baghdad 3 cv. showed the highest average of weed plants density reached 22.08 and 23.83 plant m^{-2} for both seasons respectively, when compared to Mahacv. that made the smallest average of weed plants density that reached 20.25 and 21.83 plants m^{-2} for both seasons respectively, these differences among various cultivars affecting numerical weed plant density may be due to their genetics and their nature of growth for its big ability to use the necessary growth requirements which reflected on their growth powers, this agrees with (Habeeb *et al*., 2006) and (Al-Hiti, 2017) who emphasized that cultivars of maize have different competitive qualities for the accompanied weeds.

The interaction between the study factorsalso had an intangible effect on the weed density in the spring season, when the treatment using of Arrow herbicide with recommended concentration interacted the cultivar Maha, it achieved the smallest average of weed pant density that reached 13.00 plant m^{-2}, while the result of Baghdad 3 interacting with the weedy treatment that achieved the highest numerical density of weed plants of 56.00 plant m^{-2}, this may be because the cultivar AL-Maha showed more response to the treatment of spraying Arrow herbicide with recommended concentration, which had positively reflected in controlling weed plants and reducing their density to a lower level.

Table 4: Effect of weed control treatments, the cultivars and their interact on weed density during harvest (m^2).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	15.00	13.67	13.00	13.89	Full concentration	17.67	14.00	15.00	15.56
Half concentration	17.33	17.00	14.00	16.11	Half concentration	20.67	18.67	16.67	18.67
Hand-hoeing	0.00	0.00	0.00	0.00	Hand-hoeing	0.00	0.00	0.00	0.00
weeded treatment	56.00	55.67	54.00	55.22	weeded treatment	57.00	56.33	55.67	56.33
L.S.D 0.05	1.64			1.42	L.S.D 0.05	N.S			1.93
cultivars Avg.	22.08	21.58	20.25		cultivars Avg.	23.83	22.25	21.83	
L.S.D 0.05	0.66				L.S.D 0.05	1.10			

The Effect weed control treatments on percentage of weed plants control at harvest

The results of Table5 indicated that there were significant differences in the effects of weed control treatments on the weed control percentage, treating weeds with spraying Arrow herbicide with recommended concentration gave the highest average of weed control percentage 74.85 and 72.37% for both seasons respectively in comparison with weedy treatment. This reduction may be due to the effect of the herbicide on the vital activities of the weed plants and chlorophyll degradation as it effects on green plastids and hence the decrement of photosynthesis efficiency. This is consistent with the findings of al-Khazali (2016) and Al-Hiti (2017) who assured that the use of weed herbicide may influence the vital activities of plants, leading to their death and reduce their numbers and then influence the percentage of their control.

The results also indicated that there were significant differences of the cultivars in this trait for both seasons, where Maha cv. achieved the highest weed control average of 62.49 and 60.79%, while Baghdad 3 cultivar achieved the lowest average for the trait of 60.56 and 58.19%. This may be due to Elelopathic materials extracted by these cultivars through their roots, which affects the growth inhibition of seeds and plants of the weed, decreasing their numbers, which increases the control percentage. This result is consistent with the findings of Habeeb *et al.* (2005) and Hitti (2017) who showed that there was a significant difference in the competitiveness of the maize cultivars for the weeds exist with them.

The results of current study showed that there were significant effects caused by the interact of different weed control treatments and the cultivars in the percentage of control at harvest for both seasons. The treatment of spraying of the Arrow herbicide with recommended concentration was interacted with Maha cultivar. This interaction achieved a higher control average of 75.91% in spring season, while interacting the same treatment with Fajr 1 cv. recorded the highest control average of 75.12% in the autumn season.

Baghdad 3 cv also interacted with the treatment of spray half recommended concentration and recorded the lowest average of 69.04 and 63.79%, it is may be due to the cultivars AL-Maha and Fajr 1 showed more response to the treatment of spraying herbicide with recommended concentration, which was then reflected positively in killing of weed plants and reduce their density to the lowest level, recording the highest percentage of weed plants control.

Table 5: Effect of weed control treatments, the cultivars and their interact on control percentage at harvest (%).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	73.20	75.43	75.91	74.85	Full concentration	68.96	75.12	73.05	72.37
Half concentration	69.04	69.46	74.07	70.86	Half concentration	63.79	66.81	70.10	66.90
Hand-hoeing	100	100	100	100	Hand-hoeing	100	100	100	100
weeded treatment	0.00	0.00	0.00	0.00	weeded treatment	0.00	0.00	0.00	0.00
L.S.D 0.05	2.61				L.S.D 0.05	3.89			3.41
cultivars Avg.	60.56	61.22	62.49	2.12	cultivars Avg.	58.19	60.48	60.79	
L.S.D 0.05	1.15				L.S.D 0.05	1.53			

The inhabitation percentage in the dry weight of weeds (%)

The inhibition percentage depends on the dry weight of the weed plants in the weedy treatment and the dry weight of the weed plants in the other treatments. The results in table 6 showed that the spray treatment of Arrow herbicide with recommended concentration gave the highest mean percentage of the weed inhibition of 78.19 and 78.32% respectively. This may be attributed to the high efficacy of the herbicide,

which hindered the effect of acetolactate synthase (ALS) enzyme leading to a deterioration of cell division process, this affected the dry weight of the weed plants, increasing the inhabitation ratio compared to the weedy treatment, this result agreed with the findings of Khazali (2016) and Hitti (2017), who found that the rate of inhibition increased in the weed control treatments.

The results showed that the cultivars had a significant effect on the percentage of inhibition. Baghdad 3 gave the highest mean of inhibition ration of 64.85% and 63.39% for both seasons respectively. In the spring season, Fajr 1cv gave the lowest mean of 60.36% while AL-Maha cv recorded less average for this trait of 61.62% in the autumn season. The superiority of the cultivar Baghdad 3 in the inhibition ratio indicates its high ability to compete with the other two cultivars, this is achieved through its ability to obtain nitrogen, water and photosynthesis. Trusler *et al*. (2007) indicated that the mechanical competition of weeds is due to the ability of the cultivar get food and water, which is reflected on its growth and the increased ability to compete.

The results also indicated that the inhabitation ratio was affected significantly when different weed treatments interacted with the cultivars, when the treatment of spraying Arrow herbicide with recommended concentration interacted with cultivar Baghdad 3 resulted a higher average of this trait of 82.64% and 79.89% for both seasons, while the treatment with half of recommended concentration gave the least inhabitation ratio of 65.79% and 68.18% when it interacted with cultivar Maha for both seasons.

Table 6 : Effect of weed control treatments, the cultivars and their interact on percentage of inhibition of dry weight of weed (%).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	82.64	74.29	77.64	78.19	Full concentration	79.89	76.78	78.29	78.32
Half concentration	76.74	67.16	65.79	69.9	Half concentration	73.69	70.60	68.18	70.82
Hand-hoeing	100	100	100	100	Hand-hoeing	100	100	100	100
weeded treatment	0.00	0.00	0.00	0.00	weeded treatment	0.00	0.00	0.00	0.00
L.S.D 0.05	3.41			1.36	L.S.D 0.05	1.90			1.03
cultivars Avg.	64.85	60.36	60.86		cultivars Avg.	63.39	61.85	61.62	
L.S.D 0.05	1.99				L.S.D 0.05	1.06			

Plant height (cm)

The results of Table 7 indicated that there was a significant effect of weed control treatments. Hand hoeing treatment gave the highest average of plant highest of 167.44 and 175.38 cm for both seasons respectively, while the weedy treatment gave less average of the trait of 149.00 and 152.00 cm for both seasons respectively. This result is due to the low density of weed plants in the control treatment which reduced its competition with the crop plants; this was reflected on the increase of plants height in those treatments. This result is consistent with the findings of Tahir *et al*. (2009), Al-Khazali (2016), and Al-Hiti (2017), who confirmed that the absence of weed competition to the crop plants in the control treatments led to an increase in plants height for the maize crop.

The results showed that Fajr 1 was better than the rest of the cultivars under study, where it gave the highest average of plant height of 176.33 and 174.95 cm for both seasons respectively, compared to Baghdad 3 which recorded a lowest average of 146.92 and 160.17 cm for the trait and for both seasons respectively, it is due to its genetic, as well as the length of the growth season and the delayed stages of male and female breeding, because the crop growth nature is, which in turn stops growing at the completion of flowering stage, leading to an increased division and elongation of cells, this is reflected in the increment of the plant height of some cultivars, this result agrees with Habeeb and others, (2005) and Fadhel (2010), who confirmed that maize cultivars vary in their genetic composition, which is reflected in plant height.

As to the interact between the weed control factors and the cultivars in term of the height of plant, the results of the table showed that there were significant differences in the spring season only, the hand hoeing treatment when interacted with the Fajer 1 gave the highest average of plant height of 190.33 cm, while Baghdad 3 gave a less height average of 142.33 cm when interacted with weedy treatment, this may be due to the variation of the genetic composition of Fajer 1, which showed a bigger response to the hand hoeing, resulting in a smaller competition by the weeds to the crop, then achieving the highest plants height.

Table 7 : Effect of weed control treatments, the cultivars and their interact on average plant height (cm).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	148.33	180.33	156.67	161.78	Full concentration	163.80	178.67	165.33	169.27
Half concentration	144.67	176.33	151.00	157.33	Half concentration	160.87	175.67	162.27	166.27
Hand-hoeing	152.33	190.33	159.67	167.44	Hand-hoeing	169.67	185.47	171.00	175.38
weeded treatment	142.33	158.33	146.33	149.00	weeded treatment	146.33	160.00	149.67	152.00
L.S.D 0.05	5.11			4.18	L.S.D 0.05	N.S			6.54
cultivars Avg.	146.92	176.33	153.42		cultivars Avg.	160.17	174.95	162.07	
L.S.D 0.05	2.24				L.S.D 0.05	3.00			

Leaf area (cm^2)

Results of table 8 indicated that there were significant differences in the weed control treatments and the cultivars in the leaf area for both seasons, the weedy treatment gave the lowest average of leaf area of 3582 and 3264 cm^2 for both seasons respectively, while the hand hoeing resulted the highest average for the same trait and it was of 4771 and 4927 cm^2 for both seasons respectively, and the reason of that may be due to the total absence of weed competition, as the absence of competition between weeds and crop plants over the most important growth requirements has a significant impact on the increase of leaf area, especially in the early stages of growth, where the overall growth of plants increases and the growth and volume of a leaf is stimulated, which leads to a more efficient photosynthesis process, and this result was consistent with the findings Al-Barazanchi, (2006), Al-Khazali (2016) and Al-Hiti (2017) who confirmed that the absence of weed competition in the treatments that the control operations were conducted for, led to an increase in the leaf area. The cultivars also had a significant effect on the leaf area for both seasons. Fajer 1 recorded the highest average of the leaf area of 5084 and 4712 cm^2 for both seasons respectively, while Baghdad 3 gave the lowest average for this trait of 3289 and 4078 cm^2 for both seasons respectively, this is due to the superiority of the cultivar Fajer 1 with one of the traits of vegetative growth as the height of the plant table (7), which is reflected on the leaf area, the result is consistent with Fadhel (2010), Al-Khazali (2016) and Al-Hiti (2017) who confirmed that the maize cultivars differed in their leaf areas.

With regard to the interaction between the weed control and the cultivars in terms of leaf area, the results showed that there were significant differences in the autumn season only, the treatment of the hand-hoeing, when it interacted with the cultivar Fajer 1 gave the highest average of the leaf area of 5334 cm^2, while Baghdad 3 interacted with the weedy treatment, it resulted lowest average of leaf area 2461 cm^2, and this may be due to the fact that Fajer 1 has genetic differs from other cultivars genetics and showed more response to the hand-hoeing treatment, leading to a lack of weed competition to it, hence, recording the largest leaf area.

Table 8 : Effect of weed control treatments, the cultivars and their interacton the leaf area average (cm^2).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	3300	5231	4083	4205	Full concentration	4884	4855	4431	4723
Half concentration	3067	4698	4416	4060	Half concentration	4595	4557	4750	4634
Hand-hoeing	3934	5898	4483	4771	Hand-hoeing	4373	5334	5074	4927
weeded treatment	2854	4511	3381	3582	weeded treatment	2461	4102	3227	3264
L.S.D 0.05	N.S			262.7	L.S.D 0.05	506.9			415.1
cultivars Avg.	3289	5084	4091		cultivars Avg.	4078	4712	4371	
L.S.D 0.05	274.6				L.S.D 0.05	222.0			

Net Assimilation Rate (NAR gm^{-2} leaf day^{-1})

The net assimilation rate represents the increase of photosynthesis output and with leaf area unit against time. The rate of net outputs of photosynthesis is not constant over time, and under inadequate conditions, it shows a decline as plant life progresses, it also can reflect plant capacity to produce and accumulate the dry materials (Issa, 1990).

The results of table 9 indicated a significant effect of the weed control treatments on the net assimilation rate for seasons, the hand-hoeing treatment out performed and recorded the highest average of net representation of 8.549 and 9.080 g m^{-2} leaf day^{-1} for

both seasons respectively, while the lowest average of this trait was given by competitive treatment and reached 5.878 and 6.892 g m^{-2} leaf day^{-1} for both seasons respectively, it could be due to the fact that the impact of control treatments has been most effective in lowering the density of the weed and its competition, which has made it possible for the crop to take advantage of the necessary growth requirements, this was reflected through increasing the rate of net assimilation, and then improve the growth qualities of crop.

The cultivars also significantly affected on the net assimilation rate for both seasons respectively, Fajer 1 recorded the highest average of trait of 7.795 and 8.299 g m^{-2} leaf day^{-1} for both seasons respectively, while Baghdad 3 recorded the lowest average of 7.042 and 7. g m^{-2} leaf day^{-1} for both seasons respectively. The reason behind different net assimilation rates of the cultivars is due to the different genetic nature of cultivars, also, Fajer 1 had higher plant height and leaf area (tables 7 and 8) which led to an increase in the rate of photosynthesis, this was positively reflected in the increased net assimilation for this cultivar

Table 9 : Effect of weed control treatments, the cultivars and their interact on net assimilation.

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	6.907	8.492	7.536	7.645	Full concentration	7.384	8.624	8.065	8.024
Half concentration	7.536	7.370	7.425	7.444	Half concentration	7.956	8.135	7.615	7.902
Hand-hoeing	8.182	9.029	8.436	8.549	Hand-hoeing	8.451	9.47	9.317	9.080
weeded treatment	5.544	6.289	5.801	5.878	weeded treatment	6.703	6.967	7.007	6.892
L.S.D 0.05	N.S				L.S.D 0.05	N.S			0.8022
cultivars Avg.	7.042	7.795	7.299		cultivars Avg.	7.624	8.299	8.001	
L.S.D 0.05	0.4906				L.S.D 0.05	0.3637			

Number of grains per ear (grain ear^{-1})

The total number of grains in an ear is determined by the number of grains per row and the number of rows. It was shown in the results of table 10 that significant differences between the averages of control treatments in term of grain number per row. It was noticed that the hand-hoeing gave a higher average of this trait where the number of grains per ear was 416.90 and 516.00 grain ear^{-1} for both seasons respectively, while the weed absence treatment gave a less average of this trait which was 245.70 and 367.40 grain ear^{-1} for both seasons respectively. The superiority of weed absence treatment could be due to its superiority in more than one trait of the crop traits, which reflected on the increase of grains per ear or due to the prevailing environmental conditions, which helped to increase the occurrence of pollination of maize plants, which in turn resulted the increase in the number of grains in ear. This was consistent with findings of Al-Barazanchi (2006) and Reid *et al*. (2014), who noted that the increase in the number of grains per ear at the treatments that have been controlled led to a reduce, prevent push plants or stop their competition to the crop, which increased the plants growth and hence increase the number of grains per ear.

Regarding the cultivars, the studied maize cultivars under significantly affected on this trait, where Fajer 1 gave a higher average of the ear number of 404.90 and 528.80 grain ear^{-1} for both seasons respectively, while the cultivar Baghdad 3 had the lowest value of ear number that was 282.80 and 388.20 grain ear^{-1} for both seasons respectively. This difference result from the superiority of the Fajer 1 in one or more of the traits of the crop, or from the variations of morphological, physiological, genetic traits of the cultivars or from the capacity shown by Fajer 1 to compete with weed plants and its superiority when compared to other cultivars, this is in line with what was conducted by Al-Khazali (2016), who showed that the number of grains was increasing in the treatments in which the weeds were controlled. As to the interact between the two study factors, the results indicated that there were no significant differences between averages, but there was a numerical difference among them.

Table 10 : Effect of weed control treatment, the cultivars and their interact on the number of grains average in ear (grain ear^{-1}).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	304.00	446.30	353.50	367.90	Full concentration	418.80	577.10	494.00	496.60
Half concentration	263.90	399.30	321.40	328.20	Half concentration	385.70	519.50	434.00	446.40
Hand-hoeing	342.30	499.30	409.20	416.90	Hand-hoeing	435.80	609.20	502.90	516.00
weeded treatment	221.00	274.70	241.30	245.70	weeded treatment	312.40	409.60	380.20	367.40
L.S.D 0.05	N.S			23.33	L.S.D 0.05	N.S			13.16
cultivars Avg.	282.80	404.90	331.40		cultivars Avg.	388.20	528.80	452.80	
L.S.D 0.05	24.43				L.S.D 0.05	31.22			

The weight of 500 grain (g):

The weight of the grain wasone of the main components of the total grain yield in the maize. The grains are considered to be the main and final direction of the processed foods. The weight of the seeds for each plant is a function of the rate of photosynthesis and the transmission of its products (Issa, 1990).

The results of Table 11 indicate significant differences between the averages of the different weed treatments in terms of weight of 500 seeds for both seasons respectively, while the interact between the two study factors significantly affected only the autumn season. The results had showed that there were differences between the averages of the different weed treatments in terms of weight of 500 seeds, the highest average was given by hand-hoeing treatment of 137.22 and 150.58 g for both seasons respectively, while the weedy treatment gave lower average of the same trait of 126.33 and 139.10 g for both seasons respectively. The increase in grain weight may be due to the lack of competition by the weeds in the treatment of hand-hoeing, which allowed the crop to make use of the necessary growth requirements such as light, water and nutrients. This was reflected in the improved vegetative growth of plants, such as plant height and the increase of leaf area (Tables 7, 8), thus increased the efficiency of plants in the activation of photosynthesis and the transfer of its outputs from the source to the downstream, which increased the accumulation of dry materials and thus increased the components of the crop and then increased the weight of grains. This is consistent with the findings of Muhammad & Amin (2012), who revealed that the presence of weed with crop plants lowers the weight of seeds.

Genotypes had a significant effect on that trait, Fajr 1 recorded the highest average of 138.58 and 147.75 g for both seasons respectively, whereas Baghdad 3 had a less average of 128.08 and 142.40 g for both seasons respectively. This difference may be attributed to the superiority of Fajr 1 in the traits of vegetative growth over other cultivars, as well as the difference in its genetic and phylogenetic structure, which responded to the nature of the prevailing environmental conditions in the research area and thus led to an increase in grain weight.

The interaction between the two study factors affected significantly for the autumn season only. when Fajr 1 interacted with the weed absence treatment, it recorded the highest average of 159.73 g. The same cultivar recorded the lowest average when it interacted with the weedy treatment of 136.55 g.

Table 11 : Effect of weed control treatments and cultivars and their interact on the average of weight of (500) grain (g).

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	131.33	139.00	134.33	134.89	Full concentration	141.54	153.40	145.00	146.65
Half concentration	126.67	140.00	129.67	132.11	Half concentration	143.33	141.33	140.33	141.67
Hand-hoeing	133.67	141.33	136.67	137.22	Hand-hoeing	143.67	159.73	148.33	150.58
weeded treatment	120.67	134.00	124.33	126.33	weeded treatment	141.07	136.55	139.67	139.10
L.S.D 0.05	N.S			4.26	L.S.D 0.05	8.865			8.008
cultivars Avg.	128.08	138.58	131.25		cultivars Avg.	142.4	147.75	143.33	
L.S.D 0.05	2.04				L.S.D 0.05	3.234			

Grain yield (ton h^{-1}):

The results of Table 12 showed the significant effect of the different treatments of the weed control and the cultivars for both seasons respectively on the grain yield trait for both seasons, while the interaction had given significant effects when it occurred between the factors of study for the autumn season only.

Table 12 : Effect of weed control treatments and cultivars and their interact on the average of grain yield (ton h^{-1})

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	2.56	4.58	4.34	3.82	Full concentration	4.34	5.82	5.54	5.23
Half concentration	1.88	3.74	2.57	2.73	Half concentration	2.86	5.64	3.47	3.99
Hand-hoeing	3.98	5.82	5.23	5.01	Hand-hoeing	4.17	7.19	5.80	5.72
weeded treatment	1.78	2.30	1.73	1.93	weeded treatment	2.50	3.41	3.76	3.22
L.S.D 0.05	N.S			0.98	L.S.D 0.05	1.13			0.84
cultivars Avg.	2.55	4.11	3.47		cultivars Avg.	3.47	5.51	4.64	
L.S.D 0.05	0.72				L.S.D 0.05	0.54			

The results showed the treatment of hand-hoeing achieved the highest value of the total grain yield, it was of 5.01 and 5.72 tons h^{-1} for both seasons respectively, while the weedy (comparison) treatment gave a lower average of total yield of 1.93 and 3.22 tons h^{-1} for both seasons respectively. The uniqueness of hand-hoeing treatment which gave the highest average was the result of a lack or the absence of weed plants, hence, its small competition to the crop plants (grain), which was reflected on the total grain yield.

As for the maize cultivars, they significantly affected the total grain content. Fajer 1 recorded the highest average of 4.11 and 5.51 tons h^{-1} for both seasons respectively, while Baghdad 3 had achieved the smallest average of 2.55 and 3.47 tons h^{-1} and for both seasons respectively. The reason of the superiority of Fajer 1 in term of the total grain yield is may be attributed to its superiority in one or more of the yield components, which distinguished it from the other cultivars. This result is consistent with Al-Khazali (2016), who emphasized that the carrying out the control treatments to eliminate the weed plants has led to a countable increase in the components of grain yield and thus reflected on the total grain yield.

The interaction between the study factors had a significant effect on the overall value of the autumn season only. Fajer 1 recorded the highest average value when it interacted with the treatment of the weed absence, it gave 7.19 tons h^{-1}, while the Baghdad 3 gave a lower average of the trait of 2.50 tons $h^{-1}$when it interacted with the comparison treatment.

Oil percentage in grains (%)

The results of Table 13 showed that the weed control treatments have significantly affected the ratio of oil in the grains. The hand-hoeing treatment gave the highest average of the oil percentage in grain and was 4.95 and 5.71% for both seasons respectively, while the weedy treatment recorded the lowest average of 3.37 and 3.52%. The increase in the percentage of oil in grains in the weed control treatments and its decrease in the weedy treatment may be attributed to the lack of the continuous competition on the main growth requirements between crop and weed plants, which allowed an optimum growth of the crop plants and a full exploiting to the growth requirements. This has been reflected on the grains quality.

The cultivars had a significant effect on this trait, where Fajer 1 has achieved the highest average of 4.86 and 5.49%, compared to Baghdad 3, which recorded a less average of 3.64 and 3.99% for both seasons respectively, this result could be due to different genetics of cultivars and their different responses to environmental factors during the stages of growth and development of plant, reflecting the oil content in gains.

Table 13 : Effect of weed control treatments and cultivars and their interact on the average of oil percentage in grains (%)

Spring season					Autumn season				
weed control treatments	Cultivars			Treatment average	weed control treatments	Cultivars			Treatment average
	Baghdad 3	Fajer 1	Al-Maha			Baghdad 3	Fajer 1	Al-Maha	
Full concentration	3.49	5.32	4.41	4.41	Full concentration	4.22	5.95	4.68	4.95
Half concentration	3.54	4.70	4.39	4.21	Half concentration	3.94	5.27	4.36	4.52
Hand-hoeing	4.36	5.68	4.82	4.95	Hand-hoeing	4.96	6.58	5.58	5.71
weeded treatment	3.15	3.75	3.22	3.37	weeded treatment	2.85	4.15	3.55	3.52
L.S.D 0.05	N.S			0.23	L.S.D 0.05	N.S			0.49
cultivars Avg.	3.64	4.86	4.21		cultivars Avg.	3.99	5.49	4.54	
L.S.D 0.05	0.43				L.S.D 0.05	0.37			

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